BREEDING Improved HORTICULTURAL PLANTS

By A. F. Yeager

I. Vegetables

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The cover picture is by P. E. Genereux, E. Lynn, Mass.

BREEDING Improved HORTICULTURAL PLANTS

By A. F. Yeager

Professor of Horticulture

THE PLANT-BREEDING PROGRAM at the Agricultural Experiment Station is an important activity in the University of New Hampshire's Department of Horticulture. So far, little has been printed (except in commercial nursery and seed catalogues and in short, widely scattered notes) about the tangible results of the program.

This is the first of a series of two publications which were planned to tell you about some of the accomplishments of the plant-breeding program. It is concerned with vegtables. The second publication discusses fruits, nuts, and ornamentals.

This series presents the accomplishments of the plant-breeding program as a unit. And where some progress has been made, it outlines the breeding program with crops, even though no named varieties have yet been introduced.

The development of a new plant variety (which may require a period of years) involves the efforts of many people. The plant-breeding program at the New Hampshire Agricultural Experiment Station is one of teamwork. The author directed and carried out the program with the aid of the following persons: J. R. Hepler, who did most of the work connected with the production of the New Hampshire hybrid eggplant and conducted a variety trial of peppers from which Merrimack Wonder started on its way; E. M. Meader, who was responsible for the original crosses from which Brilliant and Flash Horticultural beans and Popinjay popcorn were developed; W. D. Holley, who led the work in flower breeding and also began the breeding work with Lima beans; L. P. Latimer, who has done the major work in strawberry breeding; and W. W. Smith, who selected and crossed blueberries.

During the past eight years many University students have participated in crossing and self-pollinating plants. They have also kept records and evaluated finished products. Workmen at the greenhouses and the University farm have contributed valuable suggestions for carrying on the program. The Home Economics Department has made cooking tests and Dr. Helen Purington of the Department of Agricultural and Biological Chemistry made many analyses which have been used in making selections.

The University greenhouses have provided excellent facilities for the acceleration of the plant-breeding program. The production of a new vegetable variety which is to be propagated by seed normally requires seven generations of self-pollinated plants to purify it. But this time may be materially shortened if one generation of the crop is raised in the field with the second and third generations raised in the greenhouse during the first and second halves of the winter. It is possible to follow this procedure with many crops, thus reducing the time for rounding out the seven generations of experimental plants from seven to a little more than two years.

I. VEGETABLES

New Hampshire Plant-breeding Program Experiments with

TOMATOES — MELONS
SQUASHES
PEAS — PEPPERS
EGGPLANT
POPCORN — BEANS
CABBAGE
CARROTS

The New Hampshire Agricultural Experiment Station's plant-breeding program has made its most rapid progress with vegetable crops because the nature of the plants adapts them more readily than fruits to its advancement.

Vegetables can be developed more quickly than fruits and they do not require as much space while they are maturing. Many vegetables can complete a generation in a year or less but fruits need a much longer time. An apple tree, for instance, requires ten years to fruit from seed and it takes a long time to produce and distribute a good new variety. It is obvious, too, that an apple tree needs much more space than a bean plant to mature. These are some of the reasons why fruit-breeding operations are more expensive and more time-consuming than those carried on with vegetables.

The results of some of the Station's plant-breeding experiments with vegetables follow.

TOMATOES

The breeding work with tomatoes has proceeded along two principal lines: (1) the development of very early varieties which can be matured in the northern part of the state where the growing season is extremely short; (2) the development of tomatoes of higher nutritive value.

CHATHAM OR HOME GARDEN

The *Chatham* variety of tomato is particularly suited to short-season sections of New Hampshire. It is also grown as an extremely early variety in the southern part of the state where the fruit is sold in competition with the trellis-grown *Comet*.

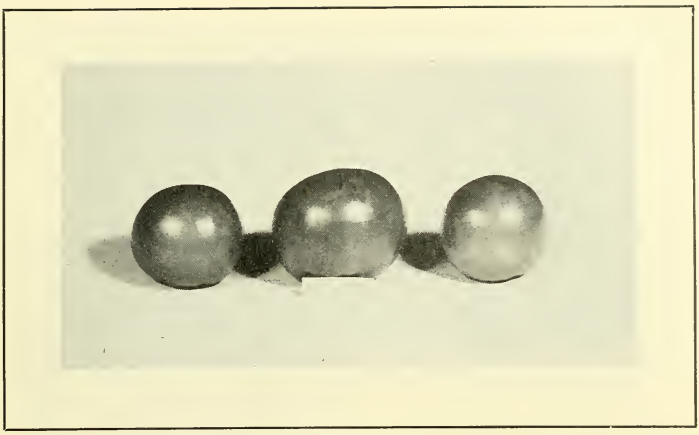
Chatham's parents were *Victor* and *Redskin*. This variety was not wholly produced at the New Hampshire Agricultural Experiment Station. It was introduced from the Michigan Station after the author moved to New Hampshire. Final selections were tested at the New Hampshire Station before they were named. *A picture of this variety is shown on the opposite page.*

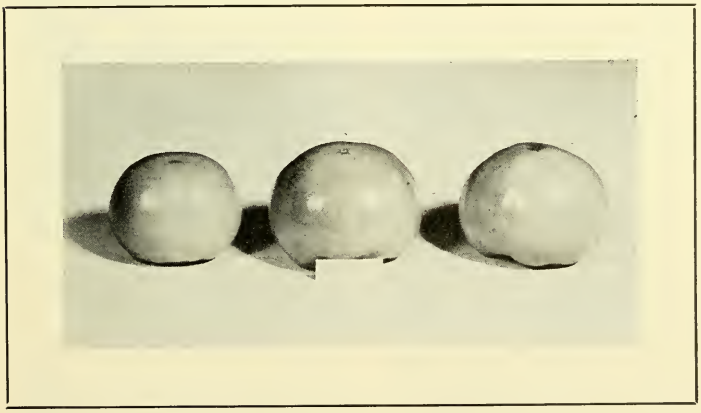
ORANGE KING

The *Orange King* variety resulted from a cross between the *New Hampshire Victor* and *Orange Dawn*, the latter an orange sport of *Scarlet Dawn*. *Orange King* is an orange-fleshed variety, is determinate in vine type, and bears fairly large oblate fruits which ripen at a medium early time. As the orange flesh is much more attractive than yellow, the variety is appreciated by people who like the golden color of its flesh and its mild flavor. *See opposite page for a picture of Orange King.*

NEW HAMPSHIRE VICTOR

The New Hampshire Victor variety came from a cross between *Allred* and *Marglobe*, made first at the





No transplanting is necessary with the Early Chatham or Home Garden tomato (top) and the fruit may be grown direct from the garden. This variety with its smooth, light-red fruit of high quality is particularly adapted to the short growing seasons of Northern New Hampshire. The Orange King (bottom) matures a little later than Chatham. The fruit is attractive in color, the flavor is mild, and the vitamin content is higher than most common varieties.

North Dakota Agricultural Experiment Station. Selections from this cross were grown at the Michigan Experiment Station along with crosses between *Allred* and *Break-O-Day*, the parents of the *Victor* variety.

When these various selected strains were moved to New Hampshire, it was found that under local conditions, the selections from *Allred* crossed with *Marglobe* retained their foliage somewhat better than did the standard *Victor* variety. Hence, this selection was named *New Hampshire Victor* as an especially adapted variety of early, large-fruited, red tomato of the determinate plant type.

ORANGE CHATHAM

The *Orange Chatham* variety was produced for the benefit of gardeners living in the sections of New Hampshire with short growing seasons. It came by crossing *Chatham* with *Orange King* and then selecting from this cross an extremely early, round, orange-fruited plant. It is primarily a novelty variety.

WINDOWBOX

Windowbox came from a cross between *Dwarf Champion* and *Redskin*. It combines the dwarf stiff plant characteristics of *Dwarf Champion* with the extreme earliness and determinate growth habit of *Redskin*. The object of making this cross was to try to furnish a tomato which would produce one large cluster of fruit on a plant about the size of a bush-bean plant, early enough so that the seed could be planted in the field under good growing conditions. *Windowbox* will do this.

Its name originated during World War II when an invalid who lived in the city asked if there was anything that she could raise in a windowbox to produce food. This tomato was sent to the woman and she successfully raised it. *Windowbox* tomatoes are of satisfactory slicing size, although they are somewhat smaller than may be desired for the general market. The variety also has proved satisfactory as an out-of-doors tomato in short seasons. The plants may be set six inches to one foot apart in the row with a distance of three feet between the rows.

Tiny Tim, a variety for winter ornament or summer cropping.

TINY TIM

Tiny Tim (shown above) came from a class plant-breeding project. The object was to discover how small a tomato plant that would mature fruit could be produced. A cross was made between *Windowbox* and *Red Currant*. Plants were selected for determinate growth habit, dwarfness, small fruits, and small plants. The result was the development of the *Tiny Tim* variety.

This variety can be grown and matured nicely in a 3½-inch pot. It was given the name "Tiny Tim" be-

Dixville, which bears the name of a famous White Mountain notch, is a large-fruited, extra-early variety.

cause it was thought that it might have value as an ornamental fruit-producing plant for Christmas decoration, competing with the Jerusalem Cherry.

When it is planted in the field, *Tiny Tim* makes a plant 12 to 24 inches across and bears quantities of cherry-sized, red fruits which may be used whole for salad purposes, if desired.

DIXVILLE

Dixville is the latest member of the early tomato family. Of a determinate plant type similar to *Chatham*, it reaches maturity slightly earlier. The fruits which are flat in shape are about twice the size of Chatham. Its ancestry goes back to the same general sources as *Chatham* crossed with a very early, determinate, small-fruited tomato known as *BV5*.

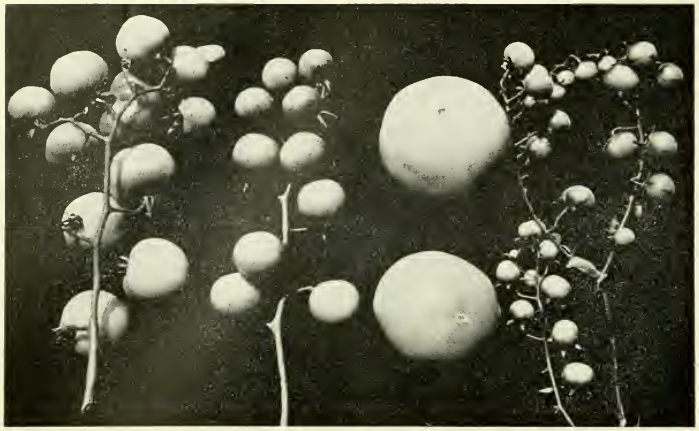
Dixville was produced in response to a need in northern New Hampshire for a large-fruited variety which would still ripen a satisfactory crop. It may be ripened satisfactorily in southern New Hampshire from seeds sown directly in the field.

The plants are small and the crown set is heavy. If they are raised commercially, they should be spaced two feet apart in a row with three feet between the rows. In common with other early, determinate sorts, *Dixville* responds to a high level of soil fertility. In 1949, this variety showed much less sun-scald on the fruit than long-vined, early varieties such as *Earliana* and *Bonnie Best.*

HIGH C

High C is the first-named production from ten years' breeding work which began with a cross made in 1938 between *Michigan State* forcing tomato and Peruvian wild tomato, *P.I. 126946.* The Peruvian tomato *(Lycopersicon peruvianum)* is distinguished by having extremely small, greenish-white fruits, each about one inch in diameter, which are sweet when ripe. These tiny fruits are not marketable. Their outstanding characteristic is their vitamin C content which is about four times as great as that of common tomatoes.

Only one seed out of several hundred fruits set was secured from the



A B C D

D, the tomato on the right, is the small, white Peruvian which has an extremely high vitamin content. C, to the left, is the large-fruited Michigan State Forcing, a good-quality variety but low in vitamins. B is the first cross between D and C. A is a selection from the second generation.

cross. But a considerable amount of seed was saved from the plant that came from that one seed, and a large generation was grown. From this the largest fruited plants and those having the highest vitamin C content were selected. The best plants among them were propagated by soft wood cuttings and back-crossed to named varieties. *Redskin* gave the best results in this back cross.

From this population some plants with fairly good-sized fruits (50 grams) and with a vitamin C content averaging 55 mg. per 100 grams were selected. The fruit still was not satisfactory in size; so selections which had both the highest vitamin content and largest fruits in this group were crossed again to *New Hampshire Victor*. In 1947, a purified selection from this population was named *High C*.

The *High C* tomato, a determinate variety, is slightly earlier than *New Hampshire Victor*. It is also smaller (80 to 100 grams) which means about five fruits per pound. The fruits are round, red, and very firm. At the University of New Hampshire the vitamin content runs from 35 to 40 mg. per 100 grams fresh weight in the average growing season. Roughly, this is double that of standard varieties of tomatoes such as *New Hampshire Victor* and *Marglobe.*

High C is extremely productive, but this high productivity is accompanied by susceptibility to early blight which may defoliate the plant before all the fruit is ripe, particularly in long growing seasons. High C probably has its greatest value at the northern limits of tomato production.

This is the new tomato developed at the University of New Hampshire. Note the characteristic, prolific plant. The smooth fruits of High C (see lower picture) are of medium size and have double the ascorbic acid content of common tomatoes.

CONTINUED WORK WITH HIGH-VITAMIN C TOMATOES

A selected indeterminate plant which has somewhat larger fruits than *High C* and is a little later in ripening had an average vitamin C content of 54 mg. in 1947. This selection, known at present as *New Hampshire No. 50*, was distributed for test in 1949. In Massachusetts, this variety analyzed from 37 to 68 mg. and, at the University of New Hampshire from 51 to 65 mg. Samples grown at the North Dakota Agricultural College analyzed as high as 69 mg. A third series of backcrosses have also been made, using a large-fruited early variety, which was distributed as *K-14*, from the Campbell Soup Company. From these backcrosses still larger fruited types have been selected. Their general characteristics are that the fruits

are round or oblong rather than oblate, are very firm, and are of good size.

Other backcrosses were made with *Long Red*. These are worthy of test as hybrid varieties in themselves with a 30 to 40 mg. vitamin C range. Selections in the second generations from this cross have now been made.

From this series of experiments in raising the vitamin C content, it has been possible to produce tomatoes of marketable size with much of the vitamin content of the small, wild Peruvian tomatoes. While some of these varieties may not, in themselves, become important in large commercial tomato-raising sections, they provide a basis for the development of canning varieties of greater food value. Thus, the vitamin C content of commercial canned tomatoes might easily be doubled, making tomatoes equal to oranges as a source of vitamin C.

MELONS

WHITE MOUNTAIN WATERMELON

The small, nearly round *White Mountain* watermelon received its name from the fact that the variety has matured its fruit north of the White Mountains where the growing season is only 100 rather cool days.

Some of the Japanese watermelons have interesting characteristics and the *Favorite Honey*, a small, yellow-fleshed variety which is oval in shape, has a thin rind, and is excellent in quality, is one of the most attractive of them. When it was thought desirable to produce a similar variety with red flesh instead of yellow, *Favorite Honey* was crossed with *Dakota Sweet*, a red-fleshed variety selected from seed introduced from Russia. The variety which resulted has red flesh, an overabundance of brown seeds, and a thin rind. It is very high in quality, and, under favorable conditions, it may mature in 65 days from seed.

The small-sized, green-striped melons weigh from two to four pounds each, resembling cantaloupes in this respect. They fit well between the shelves of a house refrigerator. As is done with small muskmelons, they are often served one-half a melon to a person.

N. H. MIDGET WATERMELON

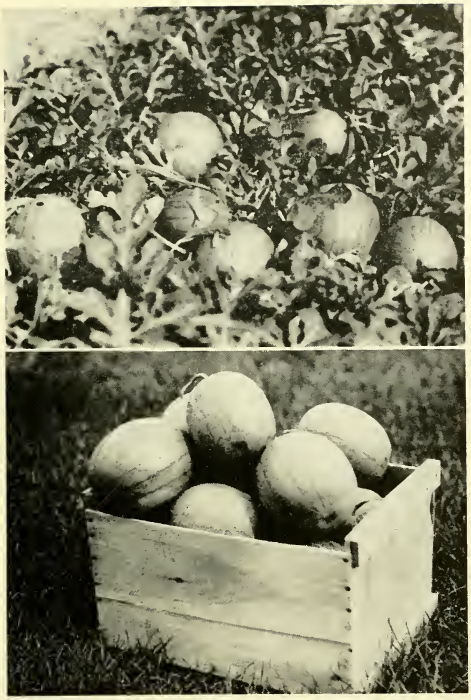
In producing the *New Hampshire Midget* watermelon a return was made to some of the earlier breeding stocks from which the *White Mountain* watermelon was developed. New selections with a smaller amount of seeds, (and those black in color) but which still maintained the high quality and small size of the *White Mountain* variety were made. In 1947, after several self-pollinated greenhouse generations, a variety with a thin, light-green mottled rind was introduced under the name of *New Hampshire Midget*.

During the season of its introduction, 200 ripe melons were produced on an 33-foot row. The first one ripened in 65 days from the time of sowing of the seeds. It is believed that this variety will have value in northern areas as a roadside market item, as well as for home use. Like cantaloupes, the size of the melons adapts them for shipment in crates.

It is very easy to determine the ripeness of *New Hampshire Midget* watermelons. When the rind is pressed by the thumb, the rind of a green melon is "springy", but when the melon is ripe, the rind is hard and crisp.

COLEBROOK WATERMELON

This variety, known in the Orient under the name *Shingyamato*, was collected in Korea by E. M. Meader



The New Hampshire Midget Watermelon is very prolific. Note the shape and size which is particularly evident in those shown in the apple box in lower picture.

who sent seeds to the University of New Hampshire in 1947. These seeds when planted at Colebrook in northern New Hampshire, ripened a satisfactory crop. As no other variety was grown on the plots, all seed was saved and increased in 1948 for introduction purposes.

Colebrook watermelons are round in shape and average about ten pounds each in weight, which is somewhat larger than *New Hampshire Midget*. They have fairly thick, striped rinds, bright red flesh, small brown seeds, and are high in quality. Some specimens are inclined to have too many seeds, but this characteristic is being corrected by the selection of the more desirable fruits. This variety resembles *Merrimack Sweetheart* and *Yankee Queen* to a considerable extent and may well have descended from the same Oriental parent.

GRANITE STATE MUSKMELON

Under New Hampshire conditions, muskmelons often fail to ripen before frost and frequently those that ripen produce fruits of poor quality. The *Granite State* muskmelon was developed to provide a melon of good quality. It came from a cross between a Michigan Experiment Station selection of *Honey Rock* crossed with a selection from a muskmelon

grown by the Mennonite farmers of southern Manitoba, Canada.

The object of the experiment was to combine the quality of *Honey Rock* with the earliness of the Mennonite variety. Selection and self-pollination for a period of six years finally resulted in the *Granite State* muskmelon, which was introduced in 1946.

The melons are of medium-size with firm, well-netted rinds and thick, bright-orange flesh. The fruit is produced in abundance and in Durham where ordinary varieties are usually flat in taste, the quality of *Granite State* melons has been excellent. The leaves of this variety are not as quickly destroyed by mildew as most others produced in this area.

OTHER MUSKMELON BREEDING

When the plants are small, ordinary muskmelons produce a great number of male blossoms; female blossoms are produced and fruit is set only after they have reached a considerable size. An introduction from India by the Office of Foreign Seed Plant Introduction (Washington, D.C.) which came to us under the designation *236-B* has all its flowers perfect, that is, they contain both pistals and stamens.

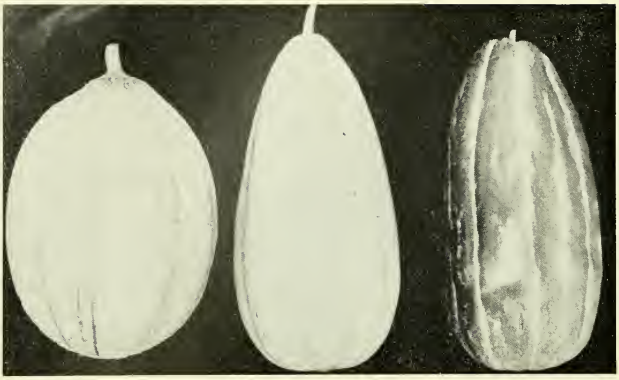
When this variety was received, it was thought that it might be possible to combine its perfect flowering habit (which results in an earlier set of fruit) and the high quality of some of our named American varieties in a single plant. Crosses were made between it and *Granite State,* and perfect-flowered selections were made in the second generation grown in the greenhouse. None proved to be entirely satisfactory as a variety to introduce; hence, a second back-cross was made with *Granite State* and again selections were made for high quality and perfect flowering. While no introductions have been made to date, a considerable number of selections have been made with thick, orange-fleshed, oval fruits, rather small in size, but high in quality and very early in maturing. Undoubtedly, a variety will be introduced from these in the near future, but some further selection and purification is required before this is accomplished.

In the spring of 1948 crosses were made between *Granite State* and the *Korean Sweet* melon, introduced by E. M. Meader. The F_1 was grown in the field in 1948. It was perfectly

A truckload of Colebrook watermelons.

The Granite State Muskmelon, developed to provide a melon of good quality for New Hampshire growing conditions, is very prolific. (See picture above.) The fruit is of medium size with well-netted rinds and thick bright-orange flesh. Note melons in lower picture.

The original perfect-flowered muskmelon which produced sour, white-fleshed, soft fruits.



A high-quality, standard muskmelon on the left; the original, perfect-flowered melon on the right; in the middle the first cross between these plants. This is the first step in producing a new variety.

A muskmelon plant fruiting in the greenhouse. Plants are trained to a string so as to make more economical use of the greenhouse space.

fertile. A large F_2 population was grown in the field in 1949 with the hope that the unusual earliness of the sweet melon might be combined with the size and thickness of flesh of *Granite State*. Very early selections of high quality were made, some of which resemble Honey Dew melon in flavor and color.

SQUASHES

BUSH BUTTERCUP SQUASH

Cucurbita Maxima, to which our true squashes belong, contains no true bush varieties. Commercial varieties grow long vines which, after producing many male blossoms at the base, finally develop pistallate blossoms several feet from the crown. Thus, the ordinary squash requires a large amount of space in the garden and is comparatively late.

A variety known as *Zapolita*, and collected by the Office of Foreign Seed Plant Introduction, is a so-called tree squash and comes the nearest to being a bush squash within

the *Maxima* species. This variety, superficially resembles *Buttercup*, but is poor in quality. Early in the season *Zapolita* behaves as a bush squash. It makes a large round plant and sets several fruits at the crown. Later the vine may grow to considerable length if the season is long.

Setting fruit at the crown is a desirable characteristic. Therefore, a cross was made between *Zapolita* and *Buttercup* and from it selections were made for quality and for plants that set fruits close to the crown. One of them, now known as the *Bush Buttercup* variety, produces fruits which closely resemble *Buttercup* in external and internal characteristics and also approach it in quality. Because it sets fruits close to the crown, *Bush Buttercup* matures in a fairly satisfactory manner in northern New Hampshire and selected seed stock has been raised for the past three years in Coos County, north of the White Mountains.

BABY BLUE

The *Bush Buttercup* squash was crossed wih *Blue Hubbard* and selections were made for small, blue-skin, orange-fleshed Hubbard-shaped fruits. By cooking individual pieces of them and selecting seed from those of the best quality, progress has been made toward the development of a near bush type, which is an easily distinguished variety of squash. This is an advantage over *Bush Buttercup*.

In the development of this variety, it has been found possible to select plants in the field early in the fall before final growth ceases and to make cuttings from the tips of the plants. The cuttings may be rooted

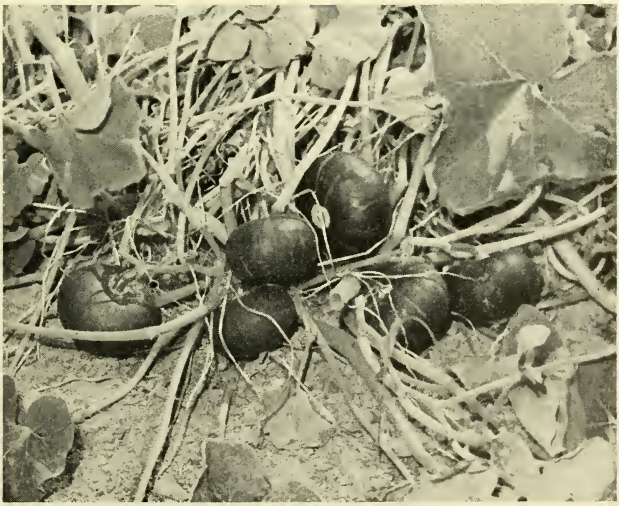


Photo by P. E. Genereaux

Bush Butternut squash. Note the turban-shaped fruits set close to the center of plant.

Baby Blue, a nearly bush type of small Blue Hubbard.

in sand and a self-pollinated generation may be matured in the greenhouse before mid-winter, a technique which eliminates the necessity for hand pollination of great numbers of squash plants in the field.

Baby Blue averages three to four pounds, a convenient weight for use by the average modern small family. It is attractive, has a thin hard shell, bright-orange, dry flesh, and keeps well. *Baby Blue* is susceptible to borers and black squash bugs, as are all *Maxima* varieties, so it will probably be most appreciated in northern squash-growing regions where these pests are not a serious problem.

The large, thick-walled Merrimack Wonder pepper is early, very productive, and of high quality.

PEPPERS

MERRIMACK WONDER PEPPER

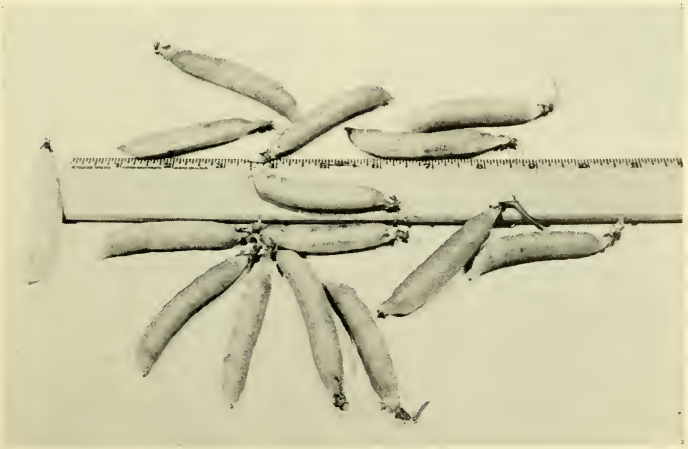
In some seasons at Durham peppers fail to set fruit. Variety and strain tests of peppers have been continued regularly for many years in an attempt to locate one that would fruit satisfactorily. During one such test a considerable number of selections were received from Dr. L. C. Curtis of the Agricultural Experiment Station at New Haven, Conn.

These selections were grown in comparison with standard varieties. In the whole field of peppers of several hundred plants, only one, a plant in one of the selections received from Dr. Curtis, made a satisfactory crop. Because of its outstanding performance, seed from this particular plant was saved. It was planted the following year and selection was continued. One greenhouse generation was raised and then a further field selection was made from the various strains developed up to this point. This was introduced as the *Merrimack Wonder* pepper, a medium-sized, blunt, thick-fleshed, sweet, early variety with special ability to produce in New England's unfavorable cool seasons.

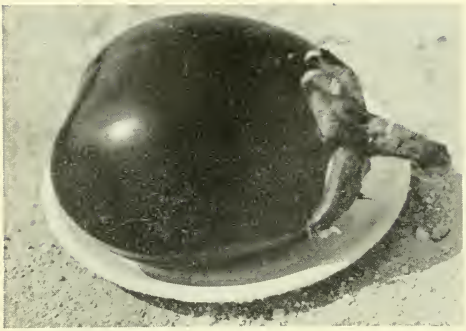
PEAS

MAYFLOWER PEA

The *Mayflower* pea resulted from a cross between *Radio*, an extremely early dwarf vareity, and *Lincoln*, a mid-season semi-dwarf variety of high quality. *Mayflower* combines the earliness and dwarf plants of *Radio* with the curved, high-quality well-filled pods of *Lincoln*. It is a first early variety and is extremely productive. The pods are somewhat larger than those of *Alaska*. The typical seeds are wrinkled and are green or yellow outside with yellow interiors. This variety has given the greatest amount of shelled peas per bushel of pods of any variety grown at Durham.



The Mayflower pea — a dwarf — is an extremely early variety and is very productive. The wrinkled seeds are of high quality.



New Hampshire Hybrid Eggplant, the standard of earlies.

EGGPLANT

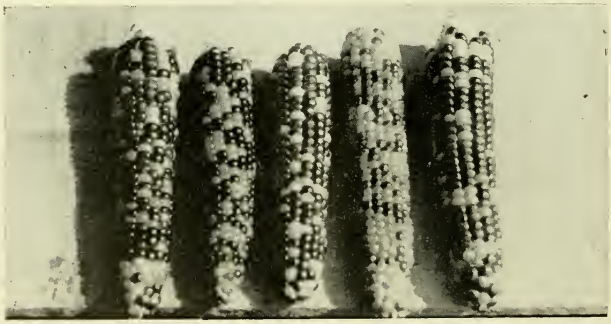
NEW HAMPSHIRE EGGPLANT

One of the first horticultural plant-breeding projects at the New Hampshire Agricultural Experiment Station was with the eggplant. The variety called the *New Hampshire Hybrid* was developed by J. R. Hepler from a cross between *Extra Early Dwarf Purple* and *Black Beauty*. Selections were made from this cross for earliness, large, dark-colored fruits, and productiveness under the cool conditions of New Hampshire. The *New Hampshire Hybrid* eggplant is now widely grown as the earliest eggplant of commercial quality. The present tendency is to call it simply *New Hampshire*, because it is a true breeding variety and not a hybrid sort, as that term is now used in the seed trade.

POPCORN

POPINJAY POPCORN

Popcorn breeding work at the University of New Hampshire started with the crossing of *Pinky*, a North Dakota-produced, pink-kerneled, high popping quality popcorn, and *New Hampshire Pearl*, a New England round-seeded, extra early,



Carnival Popcorn, a riot of color.

white variety. The first cross between these two varieties produced a beautiful popcorn. The ears had seed colors ranging from black through lavender, purple, and pink to white.

Because of this attractive appearance, it was decided to purify a variety which, while pure in other characteristics, would retain the varied-colored ears. Selections were made on the basis of earliness and high popping quality. These selections were selfed and re-combinations were made from each of the selected lines until the *Popinjay* variety resulted.

Popinjay is early enough to mature in southern New England. The popping quality is good and the ears are attractive enough to be salable in the form of braided traces at roadside stands. The product is attractive to the tourist trade and at the same time useful for food when its value as an ornament has passed.

CARNIVAL POPCORN

The *Carnival* variety was produced from a cross between *Popinjay* and *Golden Tom Thumb*. The object of the cross was to introduce into a new variety the greater earliness of *Golden Tom Thumb* and its yellow endosperm color. Again selections were made for earliness, for high-popping quality, for productiveness, and for attractive appearance. In comparison with *Popinjay*, the yellow endosperm found in some of the kernels underlying the aleurone color of *Popinjay* add a liveliness and a new variety of shades. *Carnival* is, therefore, more attractive in appearance than *Popinjay*, and has added earliness similar to *Golden Tom Thumb*. *Carnival* was named in the autumn of 1948.

BEANS

BRILLIANT HORTICULTURAL BEAN

The *Horticultural Shell* bean is an important crop in New England. The market prefers bright-colored, seeds. However, the varieties commercially grown in the area are of two kinds. The first has bright-colored seeds but poorly-colored or white pods as represented by the *Gage*, one of several local strains of the horticultural beans not available in the seed trade. Other varieties have light-colored seeds and bright-colored pods as represented by the *French Horticultural* bean.

A cross was made between *Gage* and *French* with the objective of combining the bright-colored pods of *French Horticultural* with the bright-colored seed of *Gage*. In this case, the first generation hybrid gave much of the appearance desired because the red color of the pod and the red color of the seeds are both dominant characteristics. However, when this seed was planted, segregation took place; practically all of which resulted in a return to the original combinations. Apparently there is much linkage between pod color and seed color. But, among these selections, a few plants gave the desired combination in crossovers which were purified.

The *Brilliant* variety came from one of them. It has bright-colored seeds, bright-colored pods of fairly good length, is semi-trailing, and is very productive under good growing conditions. The greatest difficulty to date has been to secure an adequate supply of seed. The unripened pods bring a premium on the market, so much so that the growers would have to get ridiculously high prices for the seed in order to make it pay for them to mature the crop.

FLASH HORTICULTURAL BEAN

The *Flash Horticultural* bean resulted from the same cross from which *Brilliant* came. *Flash* was selected and purified as a true bush type. It is somewhat earlier than *Brilliant*. Both earliness and bush habit are desirable characteristics, especially for some areas of New Hampshire. *Flash* is equally attractive and in some localities is more productive than *Brilliant*. When the soil conditions are not good, undesirably short pods are sometimes produced.

OTHER HORTICULTURAL BEAN BREEDING

In some extensive variety and strain testing, two unusually good horticultural beans were noted. One was a dwarf horticultural bean which is extremely early, has very long, bright-colored pods, but with light-color; the seeds are very large but marked with an unattractive purple.

Breeding work with horticultural beans has been continued through the crossing of these *Littleton* and *Pittsfield* beans with *Flash*. Selections have been made for bush plants, earliness, long pods, bright-colored seeds, large size, and good production. Some of these selections appear to be much superior to either *Flash* or *Brilliant* and may shortly be introduced. These strains will also be sent to bean-producing areas before final selections are chosen so that it will be possible to get an adequate production of desirable seed. Such a seed supply seems to be a requisite in the successful introduction of good horticultural bean varieties.

WHITE MOUNTAIN BUSH LIMA BEAN

In some seasons, lima beans do well in southern New Hampshire; in other years they fail either to produce pods or to mature them before frost. Failure to germinate, if cool weather comes after planting, is a common fault of lima beans.

The United States Department of Agriculture at Beltsville, Maryland, has been doing lima-bean breeding for many years with the objective of getting varieties adapted to hot summer weather. Selections were made there that would stand such conditions. Therefore, it was thought that the beans which they discarded at Beltsville might have the ability to withstand cool weather. A number of such discarded lines were secured by W. D. Holley from Dr. Roy Magruder and planted here. Most of them proved to be entirely unadapted to local conditions, but germinated under our comparatively unfavorable conditions. Selections made from them were self pollinated in the greenhouse and planted again in the field the following year.

In 1946, the soil was unusually cold at planting time, and as a result, in a one-acre plot of lima beans only eight plants grew and matured a crop. These plants, as the forerunners of new lines, were increased in the greenhouse during the winter of 1946 and the spring of 1947 and planted in the field in 1947 beside a test planting of 20 choice strains from the United States Department of Agriculture and some commercial varieties.

Many of the imported strains and varieties failed to germinate at all in our cold soil. However, three of the New Hampshire lines matured a good crop. The one designated as *No. 51* was outstanding in pod and seed size, production, and early maturity. Seed from this selection was saved and again planted in the field where it matured a large crop in 1948. Its production was equal to the best of the small-seeded varieties. Because of its large pods and large seeds, its bush habit, and its ability

The high-colored pods and seeds of Flash Horticultural Beans are brilliantly flashed with red.

to produce a crop under northern, cool climate conditions, this variety was named *White Mountain Bush* in the autumn of 1948. Seed stock is at present available only in trial quantities. It is introduced as a market-garden and home-garden variety for northern gardeners. Unsatisfactory yields were reported from Beltsville in 1948, but the stock did well in Pennsylvania and Michigan, indicating that it may not be adapted to warmer sections.

COWEY RED LIMA BEAN

In 1943, a sample of lima beans which he said was a certain cropper in his garden was received from S. D. Cowey of York Beach, Maine. This sample contained seeds of various colors ranging from almost black to red and pink, some solid colored and some mottled beans. They were planted in the University greenhouse and were found to be similar to each other so far as plant characteristics were concerned. Individual plant selections were made and the seeds planted in the field in 1944. From these individual plants, one of which had an attractive, red seed was selected. When purified, it was given the name of *Cowey Red Lima.*

The *Cowey Red Lima* is a bush variety of about the same season as the *Henderson Bush.* The seed is somewhat larger as are the pods. It is very prolific. When planted in the garden in the spring, this bean seems to have the ability to germinate under colder conditions than do most other lima beans. Probably its principal value is as breeding material. It has been used in crosses both at the University of New Hampshire and at Beltsville, in an attempt to develop more cold-resistant varieties. For immediate practical purposes, its value lies in the novelty field.

At exhibitions where these beans were shown, visitors have been much attracted to them and have requested seed.

TINY GREEN SNAP BEAN

The *Tiny Green* bean was produced as a result of a remark of a commercial canner who said that his aim was to can whole beans, though he usually canned cut ones because the pods became too large for whole canning. It was then decided to

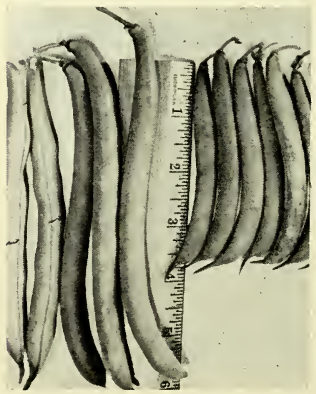
produce a variety in which the mature pod would be of a size to can whole.

As white seed beans give a clearer juice than colored beans in a canned product the aim was to work for a variety with white seeds. Harm Drewes of the Ferry-Morse Seed Company procured from Holland seed of a variety called *Perfect Stringless* to be used as breeding stock. This variety was green, and had white seed, and was small podded; but despite its name it was anything but stringless. It was crossed with *Refugee*. After several years of intensive selfing and selection in the field and in the greenhouse, a variety resulted which has white seeds; the mature pods, which are about four inches long, are round, green, and stringless. This bean, which seedsmen list as *Tiny Green*, makes an excellent canned product.

OTHER SNAP BEAN BREEDING

In 1947 work began on the development of a green snap bean which would have good color, would be a good producer, would be easy to harvest, and possibly might be harvested by mechanical means. Crosses were made between several promising varieties, including *Tiny Green*, *Streamliner*, *Bountiful*, *Tendergreen*, *Refugee*, and an unnamed variety from Australia. One generation was raised in the greenhouse and a second in the field in 1948. From this population, 158 plants have been selected for continued trials. These have several characteristics in common: they are white-seeded; they are bush varieties; they are green podded. Selections made from them in coming years should result in an improved variety as was planned.

Among the plants grown in 1948, more than 100 were tested for canning by using part of the product of the plant in a miniature jar. One of the observations made from this test was that any plant which had color in the flowers also had colored seed and when processed at 15 pounds steam pressure for an hour (as is customarily done in canning) the seeds turned a dark brown color and gave a darkened appearance to the canned product. If the seeds were white, as indicated by white blossoms, discoloration of the product did not result. White flowers, white seed, and good color in the canned product are associated in our crosses. More observations will be made on this point in the future. Color in the stems, when the plants emerge from the soil, has also indicated colored seed on the resulting plants. An exception has been noted in a white-seeded green snap bean obtained from Dr. R. A. Emerson of Cornell. This variety has colored flowers. It makes a well-colored, green canned product, as has been noted with other white seed beans.



An ordinary variety of snap beans (left) compared with Tiny Green in the usable stage (right).

RUNNER BEAN BREEDING

The runner bean, *Phaseolus multiflora,* is grown to a considerable extent in northern New Hampshire, where it is known as "lima bean" or "frost proof." There are red-and-white-blossomed varieties and purple-mottled and white-seeded varieties. Colored seed and red flowers are associated as are white seed and white flowers. There are both climbing and bush types. Selections for the white bush type have been made. It has become evident that cross-pollination in the field is very frequent in this species, so much so that it has interfered considerably with the breeding program.

Plants raised in the greenhouse in the winter when the days are short and the temperature is held fairly high have given practically no seed.

Crosses have been made between the white selections of this species and common beans, neither of which has red blossoms. The F_1 resulting has a flower nearly as bright red as the scarlet type of the runner bean. It is exactly the same color as is secured when the red-flowered runners are used in the cross. While the first generation plants are mostly infertile, some seed has been secured. Selections through the F_4 generation from this interspecific cross, which carry some of the characteristics of both parents and are highly fertile, have been made. No named varieties have resulted as yet. Further work is being done. The objectives are better flavored snap beans in which the cotyledons are not pushed above ground when the seed germinates. This is a characteristic of multiflora.

CABBAGE and CHINESE CABBAGE

Crosses have been made between the various members of the cabbage family including cabbage, kohlrabi, kale, brussel sprouts, cauliflower, and broccoli. No varieties have resulted from such hybridization, but their characteristics have been recorded. All are fertile, indicating their close botanical relationship. *Red* cabbage has also been successfully crossed with *Wong Bok Chinese* cabbage. The resulting lone plant with Wong Bok as the female parent is large, leafy, and red-veined. The plant is nearly (perhaps completely) sterile.

CARROTS

Hutchinson is the carrot variety mostly commonly grown for market purposes in New England. Unfortunately, the *Hutchinson* variety, while productive and attractive, is comparatively low in quality. *Morse's Bunching* was found to have more desirable characteristics than any other variety tested at the New Hampshire Agricultural Experiment Station. Crosses have been made between *Hutchinson* and *Morse's Bunching* with the idea of combining the good features of both. The first generation of this cross was raised in the greenhouse; seed was saved and the second generation was raised in the field in 1948. Desirable selections have been made for continued work.